

CLAIMS

What is claimed is:

- 1 1. A method for responding to a request to transfer data between a virtual
2 machine (VM) in a virtual computer system and a data storage unit within a multipath
3 data storage system, the method comprising:
4 determining multipath routing information related to possible paths over
5 which the data may be routed;
6 determining VM-specific information related to the VM in the virtual
7 computer system;
8 based on the multipath routing information and the VM-specific
9 information, deciding whether to route the data transfer request; and
10 if a decision is made to route the data transfer request, then, based on the
11 multipath routing information and the VM-specific information, selecting a path
12 over which to route the data.
- 1 2. The method of claim 1, in which the VM-specific information indicates an
2 amount of disk bandwidth that is allocated to the VM.
- 1 3. The method of claim 2, in which a decision is made not to route the data
2 transfer request because routing the data transfer request would cause the VM's
3 allocation of disk bandwidth to be exceeded.
- 1 4. The method of claim 1, in which the VM-specific information indicates the
2 VM's priority relative to other virtual machines.
- 1 5. The method of claim 1, in which the multipath routing information indicates
2 the available paths over which the data may be routed.

1 6. The method of claim 5, in which the multipath routing information further
2 indicates a pending data transfer load for each of the available paths over which the
3 data may be routed.

1 7. The method of claim 1, in which a load distribution function, based on the
2 multipath routing information and the VM-specific information, is used in selecting a path
3 over which to route the data.

1 8. The method of claim 7, in which a first VM's data transfer requests are
2 substantially always routed over a first data path as long as the first data path is
3 available, and a second VM's data transfer requests are substantially always routed
4 over a second data path as long as the second data path is available.

1 9. The method of claim 1, in which the multipath routing information indicates
2 whether a failover is occurring on one of the paths over which the data could otherwise
3 have been routed.

1 10. The method of claim 9, in which the VM is temporarily suspended if a
2 failover is occurring on one of the paths over which the data could otherwise have been
3 routed.

1 11. The method of claim 1, wherein, if a decision is made not to route the data
2 transfer request, the data transfer request is placed on a queue for routing at a later
3 time.

1 12. The method of claim 1, wherein, if a decision is made not to route the data
2 transfer request, a further decision is made whether to suspend the VM.

1 13. The method of claim 1, wherein, if a decision is made not to route the data
2 transfer request, a further decision is made whether to migrate the VM to another
3 computer system.

1 14. A computer program embodied in a tangible medium, the computer
2 program executing in a virtual computer system in support of a plurality of VMs, the
3 virtual computer system having access to a multipath data storage system, the
4 computer program comprising:
5 a resource manager for sharing system resources between the plurality of
6 VMs; and
7 a storage path manager for routing data between the plurality of VMs and
8 the data storage system, over the multiple data paths,
9 wherein the computer program determines VM-specific information and
10 multipath routing information and the storage path manager makes multipath
11 routing decisions based on both the VM-specific information and the multipath
12 routing information.

1 15. The computer program of claim 14, wherein the VM-specific information
2 and the multipath routing information are used together when making decisions
3 regarding the sharing of system resources.

1 16. The computer program of claim 15, wherein the decisions regarding the
2 sharing of system resources are based on a proportional-share approach.

1 17. The computer program of claim 14, further comprising a VM manager for
2 controlling the general operation of the plurality of VMs.

1 18. The computer program of claim 17, wherein the VM-specific information
2 and the multipath routing information are used together when making decisions
3 regarding the management of the plurality of VMs.

1 19. The computer program of claim 17, wherein the VM manager and the
2 resource manager are both implemented in a single software unit.

1 20. The computer program of claim 17, wherein the VM manager, the
2 resource manager and the storage path manager are integrated together within a
3 kernel.

1 21. The computer program of claim 17, further comprising a storage virtualizer
2 for presenting one or more portions of the data storage system to one or more of the
3 VMs as one or more virtual disk drives.

1 22. A method for selecting a path to be used for a data transfer between a VM
2 within a virtual computer system and a storage unit within a multipath data storage
3 system, the virtual computer system comprising a plurality of VMs, the method
4 comprising:

5 determining which VM within the virtual computer system is involved in the
6 data transfer;

7 determining a plurality of available paths over which the data may be
8 routed; and

9 based on the particular VM involved in the data transfer and the available
10 paths over which the data may be routed, selecting a path over which to route
11 the data.

1 23. The method of claim 22, wherein the selection of a path over which to
2 route the data is further based on information regarding pending data loads on the
3 available paths over which the data may be routed.

1 24. The method of claim 22, wherein the selection of a path over which to
2 route the data is further based on relative priorities for the plurality of VMs.

1 25. The method of claim 22, wherein the selection of a path over which to
2 route the data is further based on system resource allocations for the plurality of VMs.

1 26. The method of claim 22, wherein the selection of a path over which to
2 route the data is based on a load distribution algorithm.

1 27. The method of claim 26, wherein the load distribution algorithm is a load
2 balancing algorithm.

1 28. A method for routing data between a virtual computer system and a
2 multipath data storage system, the virtual computer system comprising a first VM and a
3 second VM, the multipath data storage system comprising a first data path and a
4 second data path between the virtual computer system and one or more data storage
5 units, the method comprising:
6 for each data transfer request:
7 determining which VM within the virtual computer system is
8 involved in the requested data transfer; and
9 if the first VM is involved in the requested data transfer, routing the
10 data over the first data path; or
11 if the second VM is involved in the requested data transfer, routing
12 the data over the second data path.

1 29. The method of claim 28, in which the one or more data storage units are
2 connected directly to the virtual computer system.

1 30. The method of claim 28, in which the one or more data storage units are
2 connected to the virtual computer system through a network.

1 31. The method of claim 30, in which the network is a storage area network.